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RFC 9398
A YANG Data Model for Internet Group Management Protocol (IGMP) and Multicast Listener Discovery (MLD) Proxy Devices

Abstract

This document defines a YANG data model that can be used to configure and manage Internet Group Management Protocol (IGMP) or Multicast Listener Discovery (MLD) Proxy devices. The YANG module in this document conforms to the Network Management Datastore Architecture (NMDA).

Status of This Memo

This is an Internet Standards Track document.

This document is a product of the Internet Engineering Task Force (IETF). It represents the consensus of the IETF community. It has received public review and has been approved for publication by the Internet Engineering Steering Group (IESG). Further information on Internet Standards is available in Section 2 of RFC 7841.

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1. Introduction

This document defines a YANG data model [RFC7950] for the management of Internet Group Management Protocol (IGMP) or Multicast Listener Discovery (MLD) Proxy devices [RFC4605]. The YANG module in this document conforms to the Network Management Datastore Architecture as defined in [RFC8342].

1.1. Terminology

The terminology for describing YANG data models is found in [RFC6020] and [RFC7950], including:

- augment
- data model
- data node
- identity
- module

The following abbreviations are used in this document and in the defined YANG data model:

IGMP: Internet Group Management Protocol [RFC3376].

MLD: Multicast Listener Discovery [RFC3810].

PIM: Protocol Independent Multicast [RFC7761].

1.2. Tree Diagrams

Tree diagrams used in this document follow the notation defined in [RFC8340].

1.3. Prefixes in Data Node Names

In this document, names of data nodes and other data model objects are often used without a prefix, as long as the context clearly indicates the YANG module in which each name is defined. Otherwise, names are prefixed using the standard prefix associated with the corresponding YANG module, as shown in Table 1.

Prefix	YANG Module	Reference
inet	ietf-inet-types	[RFC6991]
if	ietf-interfaces	[RFC8343]
rt	ietf-routing	[RFC8349]

Prefix	YANG Module	Reference
rt-types	ietf-routing-types	[RFC8294]
pim-base	ietf-pim-base	[RFC9128]

Table 1: Prefixes and Corresponding YANG Modules

2. Design of Data Model

The model covers forwarding based on IGMP and MLD proxying [RFC4605]. One goal of this document is to define a data model that provides a common user interface for IGMP/MLD Proxy devices.

2.1. Overview

The model defined in this document has all the common building blocks for IGMP/MLD Proxy devices and can be used to configure those devices. The operational state data and statistics can also be retrieved via this model.

2.2. Optional Features

This model is designed to represent the basic capability subsets of IGMP/MLD Proxies. The main design goals of this document are that (1) the basic capabilities described in the model will be supported by any major implementations that exist at the time of this writing and (2) the configuration of all implementations meeting the specifications will be easy to express through some combination of the optional features in the model and simple vendor augmentations.

This model declares two features representing capabilities that not all deployed devices support. One feature is called "igmp-proxy", and the other feature is called "mld-proxy". Either or both features could be implemented; this would provide more choices for vendors.

2.3. Position of Address Family in Hierarchy

IGMP Proxies only support IPv4, while MLD Proxies only support IPv6. The data model defined in this document can be used for both IPv4 and IPv6 address families.

This document defines IGMP Proxies and MLD Proxies in separate schema branches in the structure. The benefits of this technique are as follows:

- The model can support IGMP Proxies (IPv4), MLD Proxies (IPv6), or both, optionally and independently. Such flexibility cannot be achieved cleanly with a combined branch.
- The structure is consistent with other YANG data models such as the model defined in [RFC8652], which uses separate branches for IPv4 and IPv6.

• Having separate branches for IGMP Proxies and MLD Proxies allows minor differences in their behavior to be modeled more simply and cleanly. The two branches can better support different features and node types.

3. Module Structure

This model augments the core routing data model specified in [RFC8349].

```
  +--rw routing
     +--rw router-id?
     +--rw control-plane-protocols
     |   +--rw control-plane-protocol* [type name]
     |      +--rw type
     |      +--rw name
     |      +--rw igmp-proxy <= Augmented by this model
     |             ...
     |      +--rw mld-proxy  <= Augmented by this model
```

The "igmp-proxy" container instantiates an IGMP Proxy. The "mld-proxy" container instantiates an MLD Proxy.

3.1. IGMP Proxy Configuration and Operational State

The YANG module augments /rt:routing/rt:control-plane-protocols/rt:control-plane-protocol to add the igmp-proxy container.

All attributes related to IGMP Proxies are defined in the igmp-proxy container. The read-write attributes represent configurable data. The read-only attributes represent state data.

The igmp-version parameter represents the IGMP protocol version; the default value is 2. If the value of the "enabled" parameter is "true", it means that the IGMP Proxy is enabled.

The interface list under igmp-proxy contains upstream interfaces for an IGMP Proxy. A constraint is provided to make sure that the upstream interface for the IGMP Proxy is not configured to use PIM.

To configure a downstream interface for an IGMP Proxy, the ability to enable IGMP on that interface is needed. This is defined in "A YANG Data Model for the Internet Group Management Protocol (IGMP) and Multicast Listener Discovery (MLD)" [RFC8652].

```
augment /rt:routing/rt:control-plane-protocols
          /rt:control-plane-protocol:
  +--rw igmp-proxy! {igmp-proxy}?
     +--rw interfaces
        +--rw interface* [name]
           +--rw name                  if:interface-ref
           +--rw igmp-version?         uint8
           +--rw enabled?              boolean
           +--rw sender-source-address?   inet:ipv4-address-no-zone
           +--ro group* [group-address]
              +--ro group-address
              |       rt-types:ipv4-multicast-group-address
              +--ro up-time?        uint32
              +--ro filter-mode     enumeration
              +--ro source* [source-address]
                 +--ro source-address
                 |       inet:ipv4-address-no-zone
                 +--ro up-time?               uint32
                 +--ro downstream-interface* [name]
                    +--ro name    if:interface-ref
```

3.2. MLD Proxy Configuration and Operational State

The YANG module augments /rt:routing/rt:control-plane-protocols/rt:control-plane-protocol to add the mld-proxy container.

All attributes related to MLD Proxies are defined in the mld-proxy container. The read-write attributes represent configurable data. The read-only attributes represent state data.

The mld-version parameter represents the MLD protocol version; the default value is 2. If the value of the "enabled" parameter is "true", it means that the MLD Proxy is enabled.

The interface list under mld-proxy contains upstream interfaces for an MLD Proxy. A constraint is provided to make sure that the upstream interface for the MLD Proxy is not configured to use PIM.

To configure a downstream interface for an MLD Proxy, enable MLD on that interface. This is defined in "A YANG Data Model for the Internet Group Management Protocol (IGMP) and Multicast Listener Discovery (MLD)" [RFC8652].

```
augment /rt:routing/rt:control-plane-protocols
        /rt:control-plane-protocol:
  +--rw mld-proxy! {mld-proxy}?
     +--rw interfaces
        +--rw interface* [name]
           +--rw name                   if:interface-ref
           +--rw mld-version?           uint8
           +--rw enabled?               boolean
           +--rw sender-source-address?   inet:ipv6-address-no-zone
           +--ro group* [group-address]
              +--ro group-address
              |       rt-types:ipv6-multicast-group-address
              +--ro up-time?         uint32
              +--ro filter-mode      enumeration
              +--ro source* [source-address]
                 +--ro source-address
                 |       inet:ipv6-address-no-zone
                 +--ro up-time?               uint32
                 +--ro downstream-interface* [name]
                    +--ro name     if:interface-ref
```

4. IGMP/MLD Proxy YANG Module

This module references [RFC4605], [RFC6991], [RFC8294], [RFC8343], [RFC8349], and [RFC9128].

```
<CODE BEGINS> file "ietf-igmp-mld-proxy@2023-05-30.yang"

module ietf-igmp-mld-proxy {
  yang-version 1.1;
  namespace "urn:ietf:params:xml:ns:yang:ietf-igmp-mld-proxy";
  prefix igmp-mld-proxy;

  import ietf-inet-types {
    prefix inet;
    reference
      "RFC 6991: Common YANG Data Types";
  }
  import ietf-interfaces {
    prefix if;
    reference
      "RFC 8343: A YANG Data Model for Interface Management";
  }
  import ietf-routing {
    prefix rt;
    reference
      "RFC 8349: A YANG Data Model for Routing Management (NMDA
      Version)";
  }
  import ietf-routing-types {
    prefix rt-types;
    reference
      "RFC 8294: Common YANG Data Types for the Routing Area";
  }
  import ietf-pim-base {
```

```
      prefix pim-base;
      reference
        "RFC 9128: YANG Data Model for Protocol Independent Multicast
         (PIM)";
    }

    organization
      "IETF PIM Working Group";
    contact
      "WG Web:   <https://datatracker.ietf.org/wg/pim/>
       WG List:  <mailto:pim@ietf.org>

       Editors:  Hongji Zhao
                 <mailto:hongji.zhao@ericsson.com>

                 Xufeng Liu
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                 Mani Panchanathan
                 <mailto:mapancha@cisco.com>

                 Mahesh Sivakumar
                 <mailto:sivakumar.mahesh@gmail.com>";
    description
      "This module defines a collection of YANG definitions common for
       all Internet Group Management Protocol (IGMP) and Multicast
       Listener Discovery (MLD) Proxy devices.

       Copyright (c) 2023 IETF Trust and the persons identified as
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       (https://trustee.ietf.org/license-info).

       This version of this YANG module is part of RFC 9398; see the
       RFC itself for full legal notices.";

    revision 2023-05-30 {
      description
        "Initial revision.";
      reference
        "RFC 9398: A YANG Data Model for Internet Group Management
         Protocol (IGMP) and Multicast Listener Discovery (MLD)
         Proxy Devices";
    }

    /*
     * Features
     */

    feature igmp-proxy {
```

```
        description
          "Support for the IGMP Proxy protocol.";
        reference
          "RFC 4605: Internet Group Management Protocol (IGMP) /
           Multicast Listener Discovery (MLD)-Based Multicast Forwarding
           ('IGMP/MLD Proxying')";
      }

      feature mld-proxy {
        description
          "Support for the MLD Proxy protocol.";
        reference
          "RFC 4605: Internet Group Management Protocol (IGMP) /
           Multicast Listener Discovery (MLD)-Based Multicast Forwarding
           ('IGMP/MLD Proxying')";
      }

      /*
       * Identities
       */

      identity igmp-proxy {
        base rt:control-plane-protocol;
        description
          "IGMP Proxy protocol.";
      }

      identity mld-proxy {
        base rt:control-plane-protocol;
        description
          "MLD Proxy protocol.";
      }

      /*
       * Groupings
       */

      grouping per-interface-config-attributes {
        description
          "'config' attributes as listed under an interface entry.";
        leaf enabled {
          type boolean;
          default "true";
          description
            "Set the value to 'true' to enable the IGMP/MLD Proxy.";
        }
      } // per-interface-config-attributes

      grouping state-group-attributes {
        description
          "State group attributes.";
        leaf up-time {
          type uint32;
          units "seconds";
          description
            "The elapsed time for (S,G) or (*,G).";
        }
        leaf filter-mode {
```

```
      type enumeration {
        enum include {
          description
            "In 'include' mode, reception of packets sent
             to the specified multicast address is requested
             only from those IP source addresses listed in the
             'source' list parameter.";
        }
        enum exclude {
          description
            "In 'exclude' mode, reception of packets sent
             to the given multicast address is requested
             from all IP source addresses except those
             listed in the 'source' list parameter.";
        }
      }
      mandatory true;
      description
        "Filter mode for a multicast group.
         May be either 'include' or 'exclude'.";
    }
  } // state-group-attributes

  /* augments */

  augment "/rt:routing/rt:control-plane-protocols"
        + "/rt:control-plane-protocol" {
    when "derived-from-or-self(rt:type, "
      + "'igmp-mld-proxy:igmp-proxy')" {
      description
        "This augmentation is only valid for IGMP Proxies.";
    }
    description
      "IGMP Proxy augmentation to routing control plane protocol
       configuration and state.";
    container igmp-proxy {
      if-feature "igmp-proxy";
      presence "IGMP Proxy configuration.";
      description
        "IGMP Proxy instance configuration.";
      container interfaces {
        description
          "Contains a list of upstream interfaces.";
        list interface {
          key "name";
          description
            "List of upstream interfaces.";
          leaf name {
            type if:interface-ref;
            must 'not( current() = /rt:routing'
                + '/rt:control-plane-protocols/pim-base:pim'
                + '/pim-base:interfaces/pim-base:interface'
                + '/pim-base:name )' {
              description
                "The upstream interface for the IGMP Proxy
                 must not be configured to use PIM.";
            }
            description
```

```
              "The upstream interface name.";
          }
          leaf igmp-version {
            type uint8 {
              range "1..3";
            }
            default "2";
            description
              "IGMP version.";
          }
          uses per-interface-config-attributes;
          leaf sender-source-address {
            type inet:ipv4-address-no-zone;
            description
              "The sender source address of an
               IGMP membership report message or leave message.";
          }
          list group {
            key "group-address";
            config false;
            description
              "List of the multicast groups in the membership
               database built on this upstream interface.";
            leaf group-address {
              type rt-types:ipv4-multicast-group-address;
              description
                "Multicast group address.";
            }
            uses state-group-attributes;
            list source {
              key "source-address";
              description
                "Multicast source information
                 for the multicast group.";
              leaf source-address {
                type inet:ipv4-address-no-zone;
                description
                  "Multicast source address.";
              }
              leaf up-time {
                type uint32;
                units "seconds";
                description
                  "The elapsed time for (S,G) or (*,G).";
              }
              list downstream-interface {
                key "name";
                description
                  "List of downstream interfaces.";
                leaf name {
                  type if:interface-ref;
                  description
                    "Downstream interfaces
                     for each upstream interface.";
                }
              }
            } // list source
          } // list group
```

```
                } // interface
            } // interfaces
        }
    }

    augment "/rt:routing/rt:control-plane-protocols"
            + "/rt:control-plane-protocol" {
        when "derived-from-or-self(rt:type, "
            + "'igmp-mld-proxy:mld-proxy')" {
            description
                "This augmentation is only valid for MLD Proxies.";
        }
        description
            "MLD Proxy augmentation to routing control plane protocol
             configuration and state.";
        container mld-proxy {
            if-feature "mld-proxy";
            presence "MLD Proxy configuration.";
            description
                "MLD Proxy instance configuration.";
            container interfaces {
                description
                    "Contains a list of upstream interfaces.";
                list interface {
                    key "name";
                    description
                        "List of upstream interfaces.";
                    leaf name {
                        type if:interface-ref;
                        must 'not( current() = /rt:routing'
                            + '/rt:control-plane-protocols/pim-base:pim'
                            + '/pim-base:interfaces/pim-base:interface'
                            + '/pim-base:name )' {
                            description
                                "The upstream interface for the MLD Proxy
                                 must not be configured to use PIM.";
                        }
                        description
                            "The upstream interface name.";
                    }
                    leaf mld-version {
                        type uint8 {
                            range "1..2";
                        }
                        default "2";
                        description
                            "MLD version.";
                    }
                    uses per-interface-config-attributes;
                    leaf sender-source-address {
                        type inet:ipv6-address-no-zone;
                        description
                            "The sender source address of an
                             MLD membership report message or leave message.";
                    }
                    list group {
                        key "group-address";
                        config false;
```

```
                    description
                      "List of the multicast groups in the membership
                       database built on this upstream interface.";
                    leaf group-address {
                      type rt-types:ipv6-multicast-group-address;
                      description
                        "Multicast group address.";
                    }
                    uses state-group-attributes;
                    list source {
                      key "source-address";
                      description
                        "Multicast source information
                         for the multicast group.";
                      leaf source-address {
                        type inet:ipv6-address-no-zone;
                        description
                          "Multicast source address.";
                      }
                      leaf up-time {
                        type uint32;
                        units "seconds";
                        description
                          "The elapsed time for (S,G) or (*,G).";
                      }
                      list downstream-interface {
                        key "name";
                        description
                          "List of downstream interfaces.";
                        leaf name {
                          type if:interface-ref;
                          description
                            "Downstream interfaces
                             for each upstream interface.";
                        }
                      }
                    } // list source
                  } // list group
                } // interface
              } // interfaces
          }
        }
      }

  <CODE ENDS>
```

5. Security Considerations

The YANG module specified in this document defines a schema for data that is designed to be accessed via network management protocols such as NETCONF [RFC6241] or RESTCONF [RFC8040]. The lowest NETCONF layer is the secure transport layer, and the mandatory-to-implement secure transport is Secure Shell (SSH) [RFC6242]. The lowest RESTCONF layer is HTTPS, and the mandatory-to-implement secure transport is TLS [RFC8446].

The Network Configuration Access Control Model (NACM) [RFC8341] provides the means to restrict access for particular NETCONF or RESTCONF users to a preconfigured subset of all available NETCONF or RESTCONF protocol operations and content.

There are a number of data nodes defined in this YANG module that are writable/creatable/ deletable (i.e., config true, which is the default). These data nodes may be considered sensitive or vulnerable in some network environments. Write operations (e.g., edit-config) to these data nodes without proper protection can have a negative effect on network operations. These are the subtrees and data nodes and their sensitivity/vulnerability:

Under /rt:routing/rt:control-plane-protocols/rt:control-plane-protocol:/ igmp-mld-proxy:igmp-proxy:

igmp-mld-proxy:interfaces
>   This subtree specifies the interface list for an IGMP Proxy. Modifying the configuration may cause the IGMP Proxy interface to be deleted or changed.

igmp-mld-proxy:interfaces/interface
>   This subtree specifies the configuration for the IGMP Proxy attributes at the interface level. Modifying the configuration may cause the IGMP Proxy to be deleted or changed on a specific interface.

Under /rt:routing/rt:control-plane-protocols/rt:control-plane-protocol:/ igmp-mld-proxy:mld-proxy:

igmp-mld-proxy:interfaces
>   This subtree specifies the interface list for an MLD Proxy. Modifying the configuration may cause the MLD Proxy interface to be deleted or changed.

igmp-mld-proxy:interfaces/interface
>   This subtree specifies the configuration for the MLD Proxy attributes at the interface level. Modifying the configuration may cause the MLD Proxy to be deleted or changed on a specific interface.

Unauthorized access to any data nodes in these subtrees can adversely affect the IGMP/MLD Proxy subsystem of both the local device and the network. This may lead to network malfunctions, delivery of packets to inappropriate destinations, and other problems.

Some of the readable data nodes in this YANG module may be considered sensitive or vulnerable in some network environments. It is thus important to control read access (e.g., via get, get-config, or notification) to these data nodes. These are the subtrees and data nodes and their sensitivity/vulnerability:

```
Under
/rt:routing/rt:control-plane-protocols/rt:control-plane-protocol:/

igmp-mld-proxy:igmp-proxy
igmp-mld-proxy:mld-proxy
```

Unauthorized access to any data nodes in these subtrees can disclose operational state information about the IGMP/MLD Proxy on this device. Group information or source information may expose multicast group memberships.

6. IANA Considerations

6.1. IETF XML Registry

This document registers the following namespace URIs in the "IETF XML Registry" [RFC3688]:

URI: urn:ietf:params:xml:ns:yang:ietf-igmp-mld-proxy
Registrant Contact: The IESG.
XML: N/A; the requested URI is an XML namespace.

6.2. YANG Module Names Registry

This document registers the following YANG module in the "YANG Module Names" registry [RFC6020]:

Name: ietf-igmp-mld-proxy
Namespace: urn:ietf:params:xml:ns:yang:ietf-igmp-mld-proxy
Prefix: igmp-mld-proxy
Reference: RFC 9398

7. References

7.1. Normative References

[RFC3376]   Cain, B., Deering, S., Kouvelas, I., Fenner, B., and A. Thyagarajan, "Internet Group Management Protocol, Version 3", RFC 3376, DOI 10.17487/RFC3376, October 2002, <https://www.rfc-editor.org/info/rfc3376>.

[RFC3688]   Mealling, M., "The IETF XML Registry", BCP 81, RFC 3688, DOI 10.17487/RFC3688, January 2004, <https://www.rfc-editor.org/info/rfc3688>.

[RFC3810]   Vida, R., Ed. and L. Costa, Ed., "Multicast Listener Discovery Version 2 (MLDv2) for IPv6", RFC 3810, DOI 10.17487/RFC3810, June 2004, <https://www.rfc-editor.org/info/rfc3810>.

[RFC4605]   Fenner, B., He, H., Haberman, B., and H. Sandick, "Internet Group Management Protocol (IGMP) / Multicast Listener Discovery (MLD)-Based Multicast Forwarding ("IGMP/MLD Proxying")", RFC 4605, DOI 10.17487/RFC4605, August 2006, <https://www.rfc-editor.org/info/rfc4605>.

[RFC6020]   Bjorklund, M., Ed., "YANG - A Data Modeling Language for the Network Configuration Protocol (NETCONF)", RFC 6020, DOI 10.17487/RFC6020, October 2010, <https://www.rfc-editor.org/info/rfc6020>.

[RFC6241]   Enns, R., Ed., Bjorklund, M., Ed., Schoenwaelder, J., Ed., and A. Bierman, Ed., "Network Configuration Protocol (NETCONF)", RFC 6241, DOI 10.17487/RFC6241, June 2011, <https://www.rfc-editor.org/info/rfc6241>.

[RFC6242]   Wasserman, M., "Using the NETCONF Protocol over Secure Shell (SSH)", RFC 6242, DOI 10.17487/RFC6242, June 2011, <https://www.rfc-editor.org/info/rfc6242>.

[RFC6991]   Schoenwaelder, J., Ed., "Common YANG Data Types", RFC 6991, DOI 10.17487/RFC6991, July 2013, <https://www.rfc-editor.org/info/rfc6991>.

[RFC7950]   Bjorklund, M., Ed., "The YANG 1.1 Data Modeling Language", RFC 7950, DOI 10.17487/RFC7950, August 2016, <https://www.rfc-editor.org/info/rfc7950>.

[RFC8040]   Bierman, A., Bjorklund, M., and K. Watsen, "RESTCONF Protocol", RFC 8040, DOI 10.17487/RFC8040, January 2017, <https://www.rfc-editor.org/info/rfc8040>.

[RFC8294]   Liu, X., Qu, Y., Lindem, A., Hopps, C., and L. Berger, "Common YANG Data Types for the Routing Area", RFC 8294, DOI 10.17487/RFC8294, December 2017, <https://www.rfc-editor.org/info/rfc8294>.

[RFC8341]   Bierman, A. and M. Bjorklund, "Network Configuration Access Control Model", STD 91, RFC 8341, DOI 10.17487/RFC8341, March 2018, <https://www.rfc-editor.org/info/rfc8341>.

[RFC8342]   Bjorklund, M., Schoenwaelder, J., Shafer, P., Watsen, K., and R. Wilton, "Network Management Datastore Architecture (NMDA)", RFC 8342, DOI 10.17487/RFC8342, March 2018, <https://www.rfc-editor.org/info/rfc8342>.

[RFC8343]   Bjorklund, M., "A YANG Data Model for Interface Management", RFC 8343, DOI 10.17487/RFC8343, March 2018, <https://www.rfc-editor.org/info/rfc8343>.

[RFC8349]   Lhotka, L., Lindem, A., and Y. Qu, "A YANG Data Model for Routing Management (NMDA Version)", RFC 8349, DOI 10.17487/RFC8349, March 2018, <https://www.rfc-editor.org/info/rfc8349>.

[RFC8446]   Rescorla, E., "The Transport Layer Security (TLS) Protocol Version 1.3", RFC 8446, DOI 10.17487/RFC8446, August 2018, <https://www.rfc-editor.org/info/rfc8446>.

[RFC8652] Liu, X., Guo, F., Sivakumar, M., McAllister, P., and A. Peter, "A YANG Data Model
           for the Internet Group Management Protocol (IGMP) and Multicast Listener
           Discovery (MLD)", RFC 8652, DOI 10.17487/RFC8652, November 2019, <https://
           www.rfc-editor.org/info/rfc8652>.

[RFC9128] Liu, X., McAllister, P., Peter, A., Sivakumar, M., Liu, Y., and F. Hu, "YANG Data
           Model for Protocol Independent Multicast (PIM)", RFC 9128, DOI 10.17487/
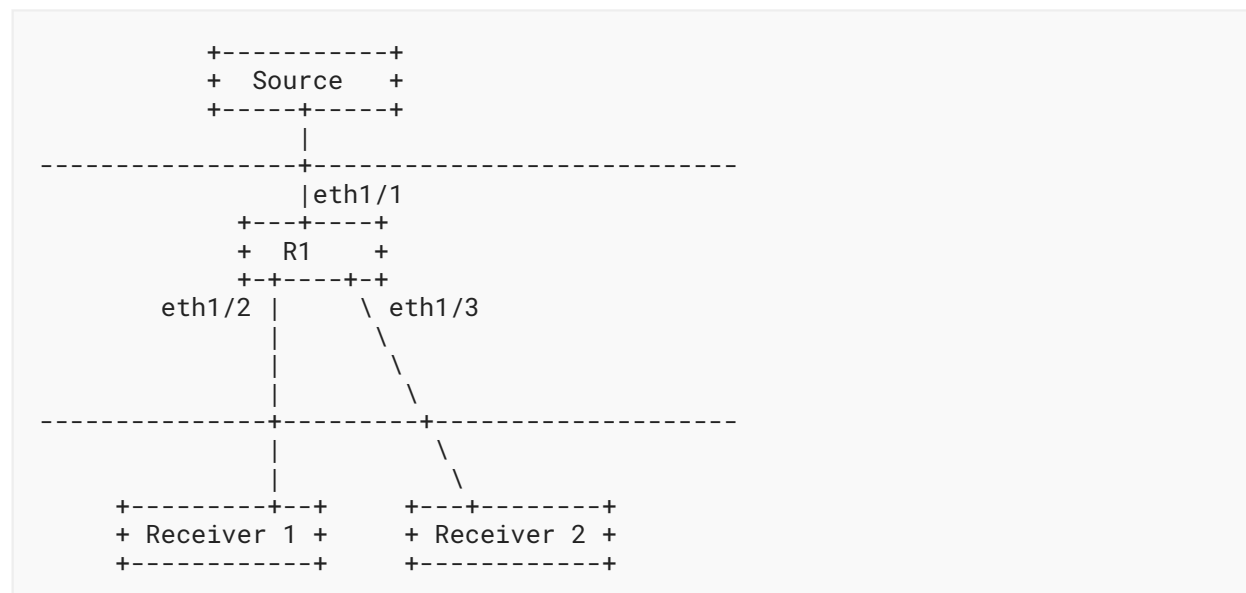   RFC9128, October 2022, <https://www.rfc-editor.org/info/rfc9128>.

7.2. Informative References

[RFC7761] Fenner, B., Handley, M., Holbrook, H., Kouvelas, I., Parekh, R., Zhang, Z., and L.
           Zheng, "Protocol Independent Multicast - Sparse Mode (PIM-SM): Protocol
           Specification (Revised)", STD 83, RFC 7761, DOI 10.17487/RFC7761, March 2016,
           <https://www.rfc-editor.org/info/rfc7761>.

[RFC7951] Lhotka, L., "JSON Encoding of Data Modeled with YANG", RFC 7951, DOI
           10.17487/RFC7951, August 2016, <https://www.rfc-editor.org/info/rfc7951>.

[RFC8340] Bjorklund, M. and L. Berger, Ed., "YANG Tree Diagrams", BCP 215, RFC 8340, DOI
           10.17487/RFC8340, March 2018, <https://www.rfc-editor.org/info/rfc8340>.

Appendix A.   Data Tree Example

This section contains an example for the IGMP Proxy, shown in JSON encoding [RFC7951] and
containing both configuration and state data. In the example, the IGMP Proxy is enabled on
interface eth1/1.

The ability to enable IGMP on eth1/2 and eth1/3 is also needed. The configuration details are
omitted here because this document is focused on IGMP/MLD Proxies.

```
         +-----------+
         +  Source   +
         +-----+-----+
               |
 ---------------+---------------------------
               |eth1/1
         +---+----+
         +  R1    +
         +-+----+-+
      eth1/2 |     \ eth1/3
             |       \
             |        \
             |         \
 --------------+---------+-------------------
             |           \
             |            \
     +--------+--+    +---+--------+
     + Receiver 1 +    + Receiver 2 +
     +-----------+    +-----------+
```

The configuration data for R1 in the above figure could be as follows:

```
{
    "ietf-interfaces:interfaces": {
      "interface": [
        {
          "name": "eth1/1",
          "type": "iana-if-type:ipForward",
          "ietf-ip:ipv4": {
            "address": [
              {
                "ip": "203.0.113.1",
                "prefix-length": 24
              }
            ]
          }
        }
      ]
    },
    "ietf-routing:routing": {
       "control-plane-protocols": {
         "control-plane-protocol": [
           {
             "type": "ietf-igmp-mld-proxy:igmp-proxy",
             "name": "proxy1",
             "ietf-igmp-mld-proxy:igmp-proxy": {
               "interfaces": {
                 "interface": [
                   {
                     "name": "eth1/1",
                     "igmp-version": 3,
                     "enabled": true
                   }
                 ]
               }
             }
           }
         ]
       }
     }
   }
```

The corresponding operational state data for R1 could be as follows:

```
{
    "ietf-interfaces:interfaces": {
      "interface": [
        {
          "name": "eth1/1",
          "type": "iana-if-type:ipForward",
          "admin-status": "up",
          "oper-status": "up",
          "if-index": 25678136,
          "statistics": {
            "discontinuity-time": "2021-05-23T10:34:56-06:00"
```

```
          },
          "ietf-ip:ipv4": {
            "address": [
              {
                "ip": "203.0.113.1",
                "prefix-length": 24
              }
            ]
          }
        }
      ]
    },
    "ietf-routing:routing": {
      "control-plane-protocols": {
        "control-plane-protocol": [
          {
            "type": "ietf-igmp-mld-proxy:igmp-proxy",
            "name": "proxy1",
            "ietf-igmp-mld-proxy:igmp-proxy": {
              "interfaces": {
                "interface": [
                  {
                    "name": "eth1/1",
                    "igmp-version": 3,
                    "enabled": true,
                    "group": [
                      {
                        "group-address": "233.252.0.23",
                        "filter-mode": "include",
                        "source": [
                          {
                            "source-address": "192.0.2.1",
                            "downstream-interface": [
                              {
                                "name": "eth1/2"
                              },
                              {
                                "name": "eth1/3"
                              }
                            ]
                          }
                        ]
                      }
                    ]
                  }
                ]
              }
            }
          }
        ]
      }
    }
  }
}
```

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